COMBINING HIGH PERFORMANCE THIN SHELL AND SURFACE CRACK FINITE ELEMENTS FOR SIMULATION OF COMBINED FAILURE MODES

B. Skallerud[a*] , **K. Holthe** [a] and **B. Haugen**[b]

[a]Department of Structural Engineering
The Norwegian University of Science and Technology
7491 Trondheim, Norway
bjorn.skallerud@mtf.ntnu.no, corresponding author

[b]FEDEM Technology inc
8700 Turnpike Drive
Westminster CO 80071, USA
bjorn.haugen@fedem.com

The present study addresses the combined failure modes of global instability, local buckling, and fracture of surface cracked shells and pipes. Usually, assessment of buckling modes and fracture are treated by different engineering communities, and by using different software. Herein, all is accounted for in an integrated software under development, denoted LINKpipe, analysing offshore pipelines. Such structures are subjected to both large displacement and rotations, and plastic deformations. The slenderness (D/t-ratio) is often relatively high, and the possibility of local instabilities has to be considered. Furthermore, pipelines consist of a multitude of weldments. Therefore one has to accept some weld defects, and fracture assessments are crucial.

A co-rotated, inelastic ANDES shell finite ele ment is employed [1]. The backward Euler stress update numerical scheme is employed along with a complete consistent tangent in the Newton equilibrium iterations. The surface cracks are accounted for using line spring finite elements. They are also impleme nted with a co-rotated formulation. To the authors knowledge, this has not been done before. Closed form stress resultant yield criteria with crack size as a parameter are used [2]. Fig. a) shows a finite element mesh of a pipe in the buckled configuration. The pipe is subjected to an eccentric compression. On the opposite side of the local buckle a semi-elliptic crack is located. With this one may evaluate the competing failure modes of buckling and fracture. Fig. b) and c) depict the global load-displacement (P-U) and J-integral versus P, respectively. In addition, the corresponding graphs for tension are plotted, showing a completely different J-evolution, as the stress redistribution is much smaller than when local buckling is present.
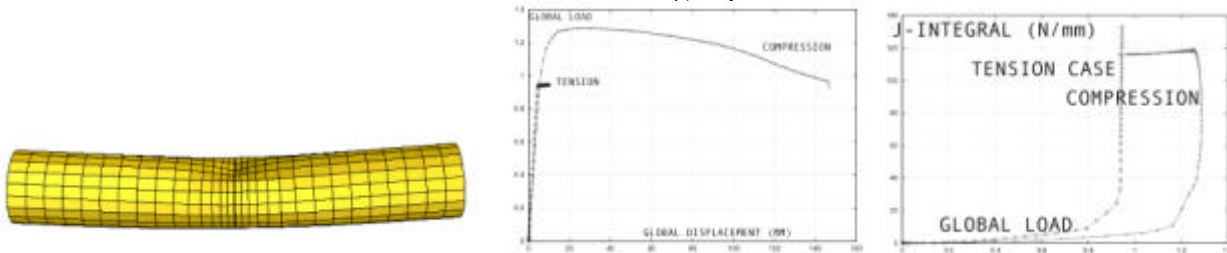
a) FE-mesh, deformed   b) P-U (upper curve is compression) c) J-P (left curve is tension)

References
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